DESCRIPTION

TITLE OF THE INVENTION: PHOSPHOR-CONTAINING CURED SILICONE, PROCESS FOR PRODUCTION OF SAME, PHOSPHOR-CONTAINING SILICONE COMPOSITION, PRECURSOR OF THE COMPOSITION, SHEET-SHAPED MOLDINGS, LED PACKAGE, LIGHT-EMITTING DEVICE, AND PROCESS FOR PRODUCTION OF LED-MOUNTED SUBSTRATE

TECHNICAL FIELD

[0001]

The present invention relates to a cured silicone containing a phosphor, a process for production of the same, a phosphor-containing silicone composition, a precursor of the composition, a sheet, an LED package, a light-emitting device and a process for production of an LED-mounted substrate. More particularly, the present invention relates to a cured silicone having a phosphor uniformly dispersed therein, which is cured by hydrosilylation. Also, the present invention relates to a process for production of an LED-mounted substrate. More particularly, the present invention relates to a process for production of an LED-mounted substrate by which a plurality of LED elements can be continuously mounted in a batch manner.

BACKGROUND ART

[0002]

A light emitting diode (LED) is characterized by low power

[0007]

Chromaticity of light emitted by an LED module is generated due to both of a deviation for the LED element (a wavelength shift and a brightness deviation of light emitted by the LED element) and a deviation for the phosphor (a deviation of an amount of the phosphor included in a sealing resin, and biasing of distribution of the phosphor in the sealing resin by the precipitation). For example, Patent Document 4 proposes a method of classifying LED modules according to the shifting of chromaticity and employing only the LED modules belonging to the same class as an LED light-emitting member so as to reduce the chromaticity deviation between the LED modules in the LED light-emitting member in the case of the LED light-emitting member having the plurality of LED modules mounted therein.

Patent Document 1: Japanese Patent Application Laid-open Publication No. 2009-173694

Patent Document 2: Japanese Patent Application Laid-open Publication No. 2009-120437

Patent Document 3: Japanese Patent Application Laid-open Publication No. 2006-339581

Patent Document 4: Japanese Patent Application Laid-open Publication No. 2010-44874

SUMMARY ~~OF THE INVENTION~~

PROBLEMS TO BE SOLVED ~~BY THE INVENTION~~

[0008]

The techniques of Patent Documents 1 and 2 have problems in that a precipitation inhibition effect of the phosphor is insufficient, and the transparency is also insufficient.

[0009]

The technique of Patent Document 3 has room for improving lightfastness and thermal resistance of a resin itself, and also has a problem to be solved, for example, requiring a complicated process to obtain core-shell type fine particles.

[0010]

The technique of Patent Document 4 requires use of special particles whose production process is complicated, and a more convenient method using an inexpensive raw material has been required.

[0011]

The present ~~invention~~disclosure paid attention to these problems, and an object thereof is to provide a cured silicone in which a phosphor is uniformly dispersed, and a silicone composition capable of inhibiting precipitation of the phosphor and also preventing a large increase in thixotropy so as to obtain the cured product, which are characterized in that a silicone material has good thermal resistance and lightfastness.

[0012]

Also, the conventional methods take a great deal of efforts and cost to produce an LED light-emitting member having

a small chromaticity deviation since they require classification of the LED modules. In order to solve these problems, however, the present ~~invention~~disclosure provides a method of conveniently manufacturing the LED light-emitting member having a small chromaticity deviation at a low cost.

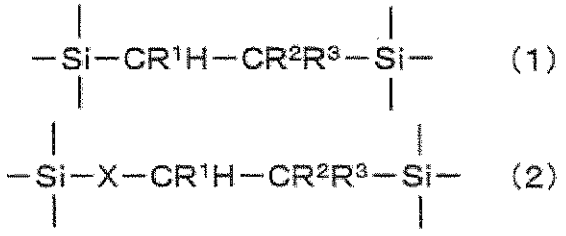
SOLUTIONS TO THE PROBLEMS

[0013]

That is, the phosphor-containing cured silicone according to the present ~~invention~~disclosure is a cured silicone which has a structure represented by general formulae (1) and/or (2) and also has units selected from general formulae (3) and/or (4), the phosphor-containing cured silicone includes a phosphor and particles having units selected from general formulae (3) and/or (4).

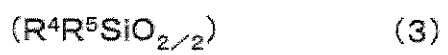
[0014]

[Chem. 1]



$$-\mathrm{Si}-\mathrm{CR^1H}-\mathrm{CR^2R^3}-\mathrm{Si}- \quad (1)$$

$$-\mathrm{Si}-\mathrm{X}-\mathrm{CR^1H}-\mathrm{CR^2R^3}-\mathrm{Si}- \quad (2)$$



$$(\mathrm{R^4R^5SiO_{2/2}}) \quad (3)$$



$$(\mathrm{R^6SiO_{3/2}}) \quad (4)$$

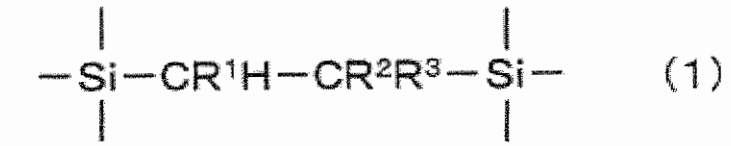
[0015]

In Formula 1, R^1 to R^3 are each a hydrogen atom, a methyl

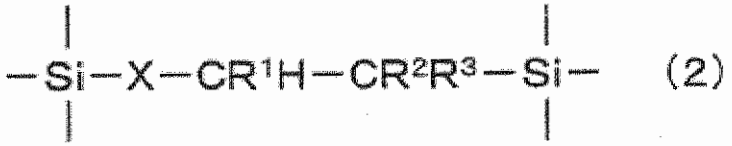
group, an ethyl group or a propyl group, X represents a methylene group, a dimethylene group or a trimethylene group, and may be the same or different, and R^4 to R^6 are each a substituted or unsubstituted monovalent hydrocarbon group, and may be the same or different.

In a first aspect, there is provided a phosphor-containing cured silicone that is a cured silicone which has a structure represented by general formulae (1) and/or (2) and also has units selected from general formulae (3) and/or (4), the phosphor-containing cured silicone includes a phosphor and particles having units selected from general formulae (3) and/or (4) said particles produced in the presence of a polymeric dispersing agent:

[Chem. 1]



(1)



(2)



(3)



(4)

wherein R^1 to R^3 are each a hydrogen atom, a methyl group, an ethyl group or a propyl group; X represents a methylene group, a dimethylene group or a trimethylene group, and may be the same or different; and R^4 to R^6 are each a substituted or unsubstituted monovalent hydrocarbon group, and may be the same or different.

Also, the phosphor-containing silicone composition according to the present ~~invention~~disclosure is a silicone composition for production of the phosphor-containing cured silicone. Here, the phosphor-containing silicone composition is a phosphor-containing silicone composition produced by mixing the following components (A) to (E):

Component (A): a compound having units selected from general formulae (5) and/or (6) and containing one or more alkenyl groups bound to one or more silicon atoms in one molecule;

Component (B): a compound having structures selected from general formulae (5) and/or (6) and containing two or more hydrogen atoms bound to a silicon atom and/or silicon atoms in one molecule;

Component (C): a hydrosilylation catalyst;

Component (D): a phosphor; and

Component (E): particles having units selected from general formulae (5) and/or (6).

[0016]

[Chem. 2]

$$(R^7R^8SiO_{2/2}) \qquad (5)$$

$$(R^9SiO_{3/2}) \qquad (6)$$

[0017]

In Formula 2, R^7 to R^9 are each a substituted or unsubstituted monovalent hydrocarbon group, and may be the same or different.

In a second aspect, there is provided a phosphor-containing silicone composition that is a silicone composition for production of the phosphor-containing cured silicone defined above, the phosphor-containing silicone composition is produced by mixing the following components (A) to (E):

Component (A): a compound having units selected from general formulae (5) and/or (6) and containing one or more alkenyl groups bound to one or more silicon atoms in one molecule;

Component (B): a compound having units selected from general formulae (5) and/or (6) and containing two or more hydrogen atoms bound to a silicon atom and/or silicon atoms in one molecule;

Component (C): a hydrosilylation catalyst;

Component (D): a phosphor; and

Component (E): particles having units selected from general formulae (5) and/or (6):

[Chem. 4]

$$(R^7R^8SiO_{2/2}) \quad (5)$$

$$(R^9SiO_{3/2}) \quad (6)$$

wherein R^7 to R^9 are each a substituted or unsubstituted monovalent hydrocarbon group, and may be the same or different.

The composition precursor according to the present ~~invention~~disclosure is a silicone composition precursor for production of the phosphor-containing silicone composition. Here, the composition precursor is produced by mixing at least two of the components (A) to (E), and has one composition selected from the group consisting of the following compositions (i) to (vii):

(i) Components (A) and (B);

(ii) Components (A) and (C);

(iii) Components (A) and (E);

(iv) Components (A), (C) and (E);

(v) Components (B) and (E);

(vi) Components (A), (B) and (E); and

(vii) Components (C) and (E).

The process for production of a phosphor-containing cured silicone according to the present ~~invention~~disclosure is one of the following production processes [1] and [2]. That is, the process for production of a phosphor-containing cured silicone is one of the process [1] of production of the

(VII) mixing a composition precursor including the component (C) with the component (D);

(VIII) mixing a composition precursor including the component (B) with a composition precursor including the component (C), followed by or at substantially the same time mixing with the component (D);

(IX) mixing the component (B) with the component (D);

(X) mixing the component (C) with the component (D); and

(XI) mixing the component (B) with the component (C), followed by or at substantially the same time mixing with the component (D).

In a third aspect, there is provided a silicone composition precursor for production of the phosphor-containing silicone composition defined above, the silicone composition precursor being produced by mixing at least two of the following components (A) to (E), and having one composition selected from the group consisting of the following compositions (i) to (vii):

Component (A): a compound having units selected from general formulae (5) and/or (6) and containing one or more alkenyl groups bound to one or more silicon atoms in one molecule;

Component (B): a compound having units selected from general formulae (5) and/or (6) and containing two or more hydrogen atoms bound to a silicon atom and/or silicon atoms in one molecule;

Component (C): a hydrosilylation catalyst;

Component (D): a phosphor; and

Component (E): particles having units selected from general formulae (5) and/or (6):

[Chem. 5]

$$(R^7R^8SiO_{2/2}) \qquad (5)$$

$$(R^9SiO_{3/2}) \qquad (6)$$

wherein R^7 to R^9 are each a substituted or unsubstituted monovalent hydrocarbon group, and may be the same or different, and

(i) Components (A) and (B);

(ii) Components (A) and (C);

(iii) Components (A) and (E);

(iv) Components (A), (C) and (E);

(v) Components (B) and (E);

(vi) Components (A), (B) and (E); and

(vii) Components (C) and (E).

In a fourth aspect, there is provided a process for production of the phosphor-containing cured silicone defined above by mixing the following components (A) to (E), the process comprising:

producing a phosphor-containing silicone composition through any one of the following operations (I) to (VIII); and

curing the phosphor-containing silicone composition:

Component (A): a compound having units selected from general formulae (5) and/or (6) and containing one or more alkenyl groups bound to one or more silicon atoms in one molecule;

Component (B): a compound having units selected from general formulae (5) and/or (6) and containing two or more hydrogen atoms bound to a silicon atom and/or silicon atoms in one molecule;

Component (C): a hydrosilylation catalyst;

Component (D): a phosphor; and

Component (E): particles having units selected from general formulae (5) and/or (6):

[Chem. 6]

$$(R^7R^8SiO_{2/2}) \qquad (5)$$

$$(R^9SiO_{3/2}) \qquad (6)$$

wherein R^7 to R^9 are each a substituted or unsubstituted monovalent hydrocarbon group, and may be the same or different, and

(I) mixing a composition precursor including the components (A), (C) and (E) with the component (B);

(II) mixing a composition precursor including the components (A) and (C) with a composition precursor including the components (B) and (E);

(III) mixing a composition precursor including the components (A), (C) and (E) with a composition precursor including the components (B) and (E);

(IV) mixing a composition precursor including the components (A) and (C) with a composition precursor including the components (A) and (B) together with the component (E);

(V) mixing a composition precursor including the components (A) and (C) with the components (A), (B) and (E);

(VI) mixing a composition precursor including the component (B) with the component (D);

(VII) mixing a composition precursor including the component (C) with the component (D); and

(VIII) mixing a composition precursor including the component (B) with a composition precursor including the component (C), followed by or at substantially the same time mixing with the component (D).

In a fifth aspect, there is provided a process for production of the phosphor-containing cured silicone defined above by mixing the following components (A) to (E), the process comprising:

producing a phosphor-containing silicone composition through any one of the following operations (IX) to (XI); and

curing the phosphor-containing silicone composition:

Component (A): a compound having units selected from general formulae (5) and/or (6) and containing one or more alkenyl groups bound to one or more silicon atoms in one molecule;

Component (B): a compound having units selected from general formulae (5) and/or (6) and containing two or more hydrogen atoms bound to a silicon atom and/or silicon atoms in one molecule;

Component (C): a hydrosilylation catalyst;

Component (D): a phosphor; and

Component (E): particles having units selected from general formulae (5) and/or (6):

[Chem. 7]

$$(R^7R^8SiO_{2/2}) \qquad (5)$$

$$(R^9SiO_{3/2}) \qquad (6)$$

wherein R^7 to R^9 are each a substituted or unsubstituted monovalent hydrocarbon group, and may be the same or different, and

(IX) mixing the component (B) with the component (D);

(X) mixing the component (C) with the component (D); and

(XI) mixing the component (B) with the component (C), followed by or at substantially the same time mixing with the component (D).

[0018]

A sheet according to the present ~~invention~~disclosure is a sheet in which the phosphor-containing cured silicone is molded on a substrate.

In a sixth aspect, there is provided a sheet in which the phosphor-containing cured silicone defined above is molded on a substrate.

[0019]

An LED package according to the present ~~invention~~disclosure is an LED package including the phosphor-containing cured silicone.

In a seventh aspect, there is provided an LED package comprising the phosphor-containing cured silicone defined above.

[0020]

A light-emitting device according to the present ~~invention~~disclosure is a light-emitting device including the LED package.

In an eighth aspect, there is provided a light-emitting device comprising the LED package defined above.

[0021]

A process for production of an LED-mounted substrate according to the present ~~invention~~disclosure is a process for producing an LED-mounted substrate by mounting an LED element on a

substrate having a circuit pattern formed therein. Here, the process includes bonding a plurality of LED elements to a substrate having a circuit pattern formed on at least one surface thereof, and then collectively sealing the plurality of LED elements with the phosphor-containing silicone composition.

In a ninth aspect, there is provided a process for production of an LED-mounted substrate by mounting an LED element on a substrate having a circuit pattern formed therein, the process comprising:

bonding a plurality of LED elements to a substrate having a circuit pattern formed on at least one surface thereof; and then

collectively sealing the plurality of LED elements with the phosphor-containing silicone composition defined above.

[0022]

Also, in the phosphor-containing cured silicone ~~according to the present invention~~as defined above, the particles preferably have a homogenous structure.

[0023]

The phosphor-containing cured silicone ~~according to the present invention~~as defined above preferably has a ratio between the transmittance at 25°C and the transmittance at 60°C at a wavelength of 450 nm of 0.8 or more when the phosphor-containing cured silicone has a thickness of 75 μm.

[0024]

The phosphor-containing cured silicone ~~according to the present invention~~as defined above preferably has a ratio between the transmittance at 25°C and the transmittance at 60°C at a wavelength of 450 nm of 0.8 or more when a cured silicone obtained by curing the particles and the components (A) to (C) has a thickness of 75 μm.

[0025]

In the phosphor-containing cured silicone ~~according to~~

~~the present inventionas~~ defined above, a difference between a refractive index d_1 of the particles and a refractive index d_2 of a region other than the particles and the phosphor is preferably less than 0.03.

[0026]

In the phosphor-containing cured silicone ~~according to the present inventionas~~ defined above, a difference between the refractive index d_1 of the particles and a refractive index d_3 of a cured product obtained by curing the components (A) to (C) is preferably less than 0.03.

[0027]

In the phosphor-containing cured silicone ~~according to the present inventionas~~ defined above, the particles preferably have an average particle diameter of 0.01 μm to 10 μm.

[0028]

In the phosphor-containing cured silicone ~~according to the present inventionas~~ defined above, the particles are preferably produced by hydrolyzing/condensing organosilane and/or a partial hydrolysate thereof.

[0029]

In the phosphor-containing cured silicone ~~according to the present inventionas~~ defined above, the particles preferably have a chain structure.

[0030]

The phosphor-containing silicone composition ~~according~~

~~to the present invention~~as defined above preferably has a yield value of 0.01 Pa or more.

EFFECTS ~~OF THE INVENTION~~

[0031]

According to the present ~~invention~~disclosure, it is possible to manufacture a cured silicone in which a phosphor is uniformly dispersed by a convenient method using an inexpensive raw material, while keeping characteristics of a silicone material that it has good thermal resistance and lightfastness.

[0032]

According to the present ~~invention~~disclosure, it is possible to reduce a chromaticity deviation of an LED-mounted substrate. When such an LED-mounted substrate is used as an LED module, it is unnecessary to classify LED modules according to their optical characteristics, and it is possible to drastically reduce the production cost of an LED light-emitting member.

BRIEF DESCRIPTION OF THE DRAWINGS

[0033]

Fig. 1 is a TEM cross-sectional image showing how to form a structure of phosphor/silicone particles.

Fig. 2 is a TEM cross-sectional image showing how to form a structure of silicone particles.

Fig. 3 is a schematic configuration diagram of the